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ABSTRACT

This paper observes that computer access affects a child's learning significantly, and presents a case study of one child's use of the computer as an example of how computer-based introduction to writing might work. The case study highlights the suitability of computers for an introduction to writing that separates the structural elements of composition from content. Specific later developments of the subject's writing are offered to suggest that the child's earlier experiences in computerized writing remained important for learning writing forms, such as short stories and friendly letters. (RL)

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A.I. Memo No. 575

LOGO Memo No. 56
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ONE CHILD'S LEARNING:

INTRODUCING WRITING WITH A COMPUTER*

R.W. Lawler

ABSTRACT

This is a case study of how one child learned to write in a computer-rich setting. Although computer access did affect her learning significantly, the details presented here go beyond supporting that claim. They provide a simple example of what a computer-based introduction to writing might be like for other children. We conclude with a short discussion of issues raised by the study.

This article was prepared for publication during a period of collaborative research between the Logo Project and the Lamplighter School of Dallas, Texas

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THE LOGO PROJECT AND THE INTIMATE STUDY -

At the end of a long study of the computer's impact on their learning, The Intimate Study, I asked my children if they thought of their experience at the Logo computer lab as being the same as or different from school. Robby (then 8) answered first:

Robby: You don't learn anything at Logo.
Bob: Oh ?... And you do at school ?
Robby: Yes.
Bob: What do you learn ?... I know you have art, for example, but you knew how to draw before you went to school.
Robby: You learn... ah... mathetating.
Bob: Mathetating ?
Robby: Mathetating: what you do with numbers.
Bob: Don't you ever do adding at Logo ?
Robby: Yeah, but all you ever learn at Logo is how to use computers.
Miriam: I learned how to write.

Miriam believed that she learned to write using computers during the period of our study. I believe it too, in a very strong sense: the particular writing which Miriam produced served her later as prototypical of what compositions should be like. For example, when taking, years later, an entrance examination which required the writing of a composition, Miriam reproduced and extended the same story she wrote at the end of The Intimate Study.

Logo at M.I.T. began as the Education Research project of the Artificial Intelligence Laboratory. More recently it also has been affiliated organizationally with M.I.T.'s Division for Study and Research in Education. An early focus was on the creation of a "mathland", a computer-rich setting wherein a child would absorb mathematical knowledge almost without realizing that she was learning.[1] (Note here that although Robby didn't do any "mathetating" at Logo, he did execute a computer project of his own imagining wherein he calculated, in order, all the primes under 50 to generate a complete

set of prime-based designs within that range.) Throughout its existence, the project's objective has been to mould the computer presence to support natural learning, that directed by the child herself.[2] Even if one's interest were restricted to the learning of arithmetic (which, at Logo, it never was), to study natural learning and to shape computers to serve natural learning, one must follow a child out of "math" worlds to others, as we do here and otherwheres. Following natural learning was my objective during the research project wherein I assembled the corpus I refer to as The Intimate Study.

The Intimate Study was six months long, tracked the learning of two children, and focussed on one (Miriam, then six years old); it was buttressed by recall of the past and enriched by noting later developmental outcomes. Miriam was a bright and an agreeable child, one working WITH her father on a project as a colleague (by this statement I imply that Miriam had much control over what we did). In this sense, the study was a sort of "cognitive anthropology" in the respect it granted to the subject. The Intimate Study was cognitive anthropology in other senses as well, in attempting to trace the child's learning beyond the confines of the lab and in depending upon naturalistic observation as well as upon the recording of pre-set experiments and working sessions. The product of The Intimate Study is a coherent corpus which can be analysed to answer such questions as, "How, precisely, did her experiences affect this child's learning to write ?" With respect to the question of Miriam's introduction to writing, the corpus is reasonably complete.

WRITING BEFORE THE INTIMATE STUDY -

Miriam didn't write much before she was six, in any standard sense of composition. There were, however, two kinds of activities she engaged in which can be seen as the precursors of the stories and letters she wrote later. A typical precursor of story writing was a kindergarden activity where the teacher or one of her helpers asked a child to tell the story of a picture the child had drawn. She then wrote the story on a piece of paper and attached it to the picture. My favorite of the genre is this:

> It's a sunny day in my picture. People are sailing on the river.
> A boy and a girl are happy together.

In the year preceding The Intimate Study, a large portion of Miriam's drawings took the form of "presents" she made for others. A typical example is this: after drawing a picture of "football Fred" from Ed Emberley's DRAWING BOOK OF FACES, Miriam prepared it as a gift for her playmate Brian. Miriam wrote at the side "football Fred" and at the top "To Brian/Love/Miriam". (The "/" indicates a new line.) Miriam spoke of such drawings as presents many times. One formal element of these notes reflects that character. Each typically bore a "tag" with conjoined salutation and closing. Her initial tags were of the form "To _____/From Miriam". I believe the change to the later tag form "To _____/Love/Miriam" was influenced by receiving postcards from her great-grandmother who closed her every missive with the valediction "Love/G.G."

WRITING STORIES -

The central idea of the writing experiences in The Intimate Study was to segregate the content and structure of writing by use of a computer language interface. The reasons for doing so were as follows. A major problem of all writing instruction is

sensitizing the writer to the expectations of the audience. Even mature writers face the difficulty of discriminating between the desire for expression and the restraint that is often required for effective communication. Such a problem is exacerbated when the writer is a young child, one who may be unused to casting herself imaginatively in the role of a possible audience for the text she is composing, one who may not even conceive of the purpose of writing as effective communication. The strategy embodied in the idea of a computer language interface is to pre-establish the structure of a piece of text and to form the content of the text from the writer's direct expression; the final end, to be hoped for if not achieved, is that the writer in reading and re-reading her own composition will first perceive the structure vaguely as an envelope surrounding her content and later as a specific form into which she can cast her content for its effective communication.

Effective natural learning requires that material to be learned relate simply to the learner's past, personal experiences. I was fortunate in being able to present Miriam as a generalized story structure a specific joke-script by which she had recently victimized me:

Miriam: Would you like to hear a short story ?
Bob: Sure.
Miriam: Once upon a time, the end. That's a SHORT story.

Through the WRITER interface, Miriam encountered a story template whose first line was "Once upon a time," and whose last was "The end." In between these two lines, Miriam was able to interpolate any story lines she might wish. The WRITER interface generated a procedure whose execution would display on the video terminal the text of the story (after which it could be simply copied to a printer). When I introduced the WRITER interface, Miriam objected of the template story ("Once upon a time,/The end.") "That's

not any nice story !" Agreeing with her, I was still able to argue that we had a beginning and an end, all we had to do was write the middle part.

The execution of the WRITER interface was straightforward. Keying "WRITER" invoked the interface which cleared the video display and displayed the opening line, "Once upon a time," with the procedure line number it would have in the procedure-to-be-generated. Miriam keyed her middle part, line by line, and assigned each line a number for its ordering in the procedure-to-be-generated. When she keyed "END" instead of some other text, the WRITER interface displayed "The end." and requested a name for the procedure-to-be-generated. After generation and WRITER's termination, the story could be displayed by keying the new procedure's name.

Miriam confronted two major difficulties in the use of WRITER. The first problem was what to write. The second, how to do it, was manifested primarily as ignorance of spelling. This should be no surprise. If a child writes little more than her name, why should she learn to spell words letter by letter when such detailed knowledge is not necessary for speaking and may not be a stringent requirement for reading ? The content of Miriam's early stories is highly idiosyncratic, e.g.:

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P STORY
ONCE UPON A TIME
P WAS TIRED OF FOLLOWING Q.
HE STARTED AT THE BEGINNING OF THE ALPHABET.
PABCDEFGHIJKLMNOQRSTUVWXYZ.
THE END.
```

My prejudices would have judged this P STORY as remote from anything which would engage a child. It did engage Miriam, however, as is witnessed by her later claim of authorship when she showed the text to Robby and he said it was nice.

In the first four weekly composition sessions (spread among the daily sessions

of other focus), Miriam wrote three more "letter stories". Why would any child persist in elaborating such unpromising material as Miriam's original "P Story" ? One possibility is the pervasive burden of spelling to a novice writer, i.e. the choice is to write a story most of the words of which she recently learned to spell. A second possibility is that Miriam owned no alternative, salient script for a story in the specific context "writing computer stories". I found her elaborations sterile and boring and intervened in major ways to alter Miriam's writing. First I removed the spelling burden by taking on the role of Miriam's amanuensis and put the composition task in an oral context by introducing a variation of WRITER as a special tool for writing out the text of songs. While Miriam recited her favorite kindergarden song ("Little Rabbit Foofoo/Hopping through the forest/Scooping up the field mice/ And bopping them on the head,/..."), I keyed the text and produced printed output which Miriam copied and shared with her kindergarden classmates the following day. In the next writing session, I followed Miriam's lead. She composed orally - and I keyed at her dictation - a version of the Goldilocks story as a play-script for her kindergarden classmates. Miriam's script proved of limited use (the other actresses couldn't read), but the next day in kindergarden and subsequently when a friend came to play at Logo, the children dutifully carried their copies about as they were "supposed to" .

THE MOST FULLY DEVELOPED STORY -

These two interventions liberated Miriam's conception of what it was possible for a computer written story to be like. The next week she asked to write another story. This story, SCURRY, was her most developed story made during The Intimate Study.

SCURRY
ONCE UPON A TIME,
WE GOT A DOG NEAR VALENTINE'S DAY.
AND WE DID NOT KNOW WHAT TO CALL IT
AFTER A WEEK WE DECIDED TO CALL IT SCURRY.
AND WE FIGHTED OVER IT.
THE END.

The extensive citation below of her composing SCURRY shows Miriam with a much more liberal conception of what a story may be like but with her production of text still much encumbered by the need for extensive spelling advice.

Bob: So we start with "Once upon a time,"... what's a good story ?
Miriam: I know.
Bob: What ?... Oh no ! Not another one of those letter stories. How about something about Scurry ? Or the Three Little Pigs ?
Miriam: Phooey... When did we get Scurry ?
Bob: I think it was around Valentine's Day. That's right, because she was really a Valentine's present for your Mommy.
Miriam: She's around nine months.
Bob: If you had a story, you could write "Once upon a time, we had no dog."
Miriam: (Having begun to type) How do you spell "got" ?
Bob: G, O, T.
Miriam: Will you spell "near Valentine's" ?
Bob: "Near". You want me to write it ?... There's "near". You try that.
Miriam: N, E, A, R (keying). "Valentine's". Don't write "day", don't write it.
Bob: That's the way you write "Valentine's".
Miriam: A, L, E, N, T, I, N, E,... what's that little thing there ?
Bob: An apostrophe. You have to use the shift key, there. Then there's an "S" on the end.
Miriam: How do you spell "know", not N, O.
Bob: That other one. That's really a tricky one.
Miriam: Say it while you're spelling it.
Bob: K, N, O, W.
Miriam: "WHAT".
Bob: What ?...O.K. W, H, A, T.
Miriam: How do you spell "call" ?
Bob: C, A, L, L.
Miriam: (keying then re-reading) Call it.... We got a dog near Valentine's day and didn't know what to call it.... How do you spell "after" ?
Bob: A, F, T, E, R.
Miriam: How do you spell "week" ?
Bob: W, E, E, K.
Miriam: Will you type "decided" ?
Bob: No. I'll spell it though, a little at a time. D, E, - C, I, D - E, D.

Miriam: How do you spell "Scurry" ? S,...
Bob: C, U, R, R, Y.
Miriam: I don't want to write anymore. Type "end" ?
Bob: That's the end of the story ? Is it a good name ? Why did we pick it ? Do you want to tell that, or just quit ?
Miriam: How do you spell "fighted" ?
Bob: Fighted ? F, I, G, H, T, E, D.
Miriam: Fighted. How do you spell "over" ?
Bob: (writing down the answer) Did we fight over the name ?
Miriam: No.
Bob: Over Scurry.

EFFECTS BEYOND THE COMPUTER LABORATORY -

In the preceding citation, we have seen the use of a very simple three part story form (beginning, middle, end) with a newly flexible middle developed. How much of this script became Miriam's property, in the specific sense that she used it spontaneously ? Two incidents of succeeding days showed the WRITER template used outside the laboratory:

Robby called me from Miriam's bedroom: "Dad, come see the puppet show." They have played with, even made hand puppets for a while and enjoy giving shows -- whose typical script has been "Hello. My name is Owl. Goodbye."

Walking through the door unsuspecting, I found the children were playing "Ambush" -- both were lying under covers on the top bunk. They cried "BAM ! BAM !" as I walked through the door. Riotous laughter.

Suffering only flesh wounds, I managed to return their fire, then said I thought it a dirty trick for them to call me to see a puppet show and shoot me. Miriam responded, "This was our puppet show:

Once upon a time,
There were two guns.
Bang. Bang.
The end."

Her joke was a spontaneous expression of the WRITER program's story format. Her use of it in this explanatory way shows her recognition that it was a shared model of story structure.

That same evening, Miriam, who had of late been making "late mother's day presents", brought me an "early father's day present". The present was a drawing of one of her typical flowers with this story:

Once upon a time,
A flower was sitting on a hill.
And someone came and pick it.
The end.

Miriam could not spell the words, I was told, and had dictated the story to her brother after drawing the picture.

LONG TERM EFFECTS -

Miriam recalls writing no stories at all during her two years of public school after The Intimate Study. Before entering third grade in a different program, she took an entrance examination which required her to write a composition. The composition, MY DOG, is presented in Figure I. MY DOG (a title selected from a list of ten very general suggestions) shows the thematic influence of the much earlier work both in the theme chosen and in the initial detail presented. The episodic continuation beyond the earlier Scurry material derived directly from the requirement that the composition be one hundred words long. The two other compositions in Figure I, both written by hand at my request, show the residual influence of the earlier story script. Most importantly, that experience provided a shared, albeit simple, idea of story structure which permitted my criticism that "the Children's Museum" simply stopped without ending and that it was possible to use other beginnings. I believe my suggestion that "the Children's Museum" needed a conclusion or a summary sentence led Miriam to provide such for "My Friend Liz".

My conclusion is that Miriam's early experience with the WRITER interface at Logo left her with a stereotypical form for short story and even default thematic elements (which were easily overridden if occasion required it). Further, I speculate that the early presentation of a form with a beginning, middle, and end permitted Miriam's comprehension of my criticism of the form of one story, as shown by the presence of a summarizing conclusion in her next composition.

FIGURE I

My Dog

We got a dog near Valente's day for my mother. We named the dog Scurry my little sister is always running around with Scurry. Scurry will be three in September. Once when Scurry had a bath she jumped out of the bathtub and got me and my mother all wet. Sometimes I have to take Scurry for a walk in the woods and sometimes I have to feed Scurry and give her water. Sometimes my mother takes Scurry and my little sister for walks. Sometimes Scurry runs away and me, my brother, and my mother have to go find her.

the Children's Museum

Once upon a time I went to the Children's Museum. I had a lot of fun playing with the computers. I played "wumpus" and "tic-tac-toe". I also played with a big "wonderful waterful". I also looked through a pair of glasses about 4' x 4'. They let us use a weelchair (small in-line drawing) and a kind of crutch like this (small in-line drawing). I also played dentist with my father.

My Friend Liz

Once upon a time I invited my friend Liz over to the Logo lab. I had a lot of fun with her. We played with the computers. We each bought 2 sodas and a pack of diamints. (dynamints) I took Lizzy to look all around Logo. Lizzy and me had a lot of fun.

WRITING LETTERS -

The standard form of a simple letter is only slightly more complicated than the general story script of the WRITER interface. In place of the stereotypical beginning "Once upon a time", the letter head is dated and introduced with the salutation "Dear -----,". A letter typically concludes with a conventional closing. For "The end." is substituted a phrase which suggests the relation of the writer and recipient. The LETTER interface functioned as did WRITER with the added complications of asking for the weekday, a date and the recipient's name and requiring a manual signature to complete the letter.

Miriam used LETTER to write letters to a school friend, to her great grandmother in a distant city and even to make a supper invitation for Logo colleagues whose paths crossed ours too infrequently to be certain of meeting them. But with one unusual exception not too much should be made of the utility to a child of letter writing. (The telephone is easier to use and can be a more personal and immediate contact.) Even though her choices were significant in selecting which one of several possible activities we would pursue on any particular day, Miriam's letters were written at my request as part of our study, as her earlier stories had been.

Miriam's favorite school friend was Maria, whose parents barely spoke English and who returned with her to their native Spain in the middle of our study. Miriam could not play after school where Maria lived, and it was nearly impossible to arrange by 'phone for Maria to visit us. Miriam gave a letter to Maria at school to arrange a visit to our house and later sent her a letter in Spain. In her three letters to Maria, Miriam's primary difficulty was with spelling. Consider her first letter:

MONDAY, JUNE 13

DEAR MARIA,
I LOVE YOU.
I WILL MISS YOU WHEN YOU GO TO SPAIN.
WILL YOU COME TO PLAY WITH ME ON WEDNESDAY ?
YOUR FRIEND,

While keying, Miriam asked me to spell these words: Monday, June; will, miss, when, Spain; come, play, with, Wednesday. ("Dear" and "Your Friend" were generated by the letter interface.)

Miriam answered the questions about the week day and date; they were easy questions, part of a simple and unquestioned convention. In her letters to Maria, the significance of the heading date never rose as an issue - as it did with this letter to her great-grandmother:

MONDAY, AUGUST 8

DEAR GG,
I MADE A DIAORAMA ON SUNDAY.
IT HAD 2 TREES, A BUSH, A LAKE,
A ELEPHANT (WHICH IS QUITE LOVABLE),
A BUNNY RABBIT, AND A TURTLE.

WE HAVE A DOG NAMED SCURRY. SHE
IS LOVABLE BECAUSE SHE'S SO FUZZY.

MOMMY HAD A BIRTHDAY TODAY.

I MADE A BABY BUNNY FOR MY DIORAMA.

YOURS TRULY,

As she dictated to me her letter to G.G., we became embroiled in the complications of relative dating:

Miriam: (To Bob who is keying) Say," Mommy had a birthday yesterday."
Bob: Today's her birthday.
Miriam: Yeah, but it will get there (where GG is) tomorrow.
Bob: But we told her at the top of the letter what day it is, so she knows what day you write it.
Miriam: Oh.

Bob: That's one of the reasons we put the date on, so she can figure out things like that. It's a good hint for her to figure out what's going on.... Well, do you want to say "Mommy has a birthday today" or "Mommy has a birthday tomorrow" ?
Miriam: Had one today.
Bob: (keying) Mommy has a birthday --
Miriam: (interrupting to correct) Had !
Bob: Sorry. I thought you said "has". "Had a birthday today".

Through this accident, Miriam had the opportunity to learn how what first appeared as merely a conventional feature of the given letter structure solved a comprehensible problem to which she was sensitive.

Miriam's most fully developed letter, that below to DANNY AND MARGARET, conjoins text with decoration, a flower created by a Logo procedure she had written. This new format (my suggestion) made Miriam's letter more like those early presents she had delighted in making - with the addition of a significantly extended textual component. When she later made party invitations on the computer, Miriam kept this format. Spelling remained a primary problem, enough of a problem that she changed her selection of specific phrases to circumvent spelling uncertainties. Originally, for example, we planned to ask Danny and Margaret to supper on Wednesday. Miriam chose to refer to that day as the "31 of August" (copying "August" from her earlier use of it in the heading) to avoid asking for help in spelling Wednesday.

MONDAY, AUGUST 29
DEAR DANNY AND MARGARET,
WILL YOU COME TO OUR PLACE
ON THE 31ST OF AUGUST
AT 5 O'CLOCK SO YOU CAN TAKE A LOOK AT
THE TREE FORT BECAUSE SOMEONE SAWED OFF THE
BARNCH THAT WAS SUPPORTING IT.
YOU ALSO CAN HAVE SUPPER WITH US.
YOUR FRIEND,

It is difficult to trace any specific element of this computer letter writing in Miriam's

letters of later date. She writes few letters, and most are written with a specific purpose (which would tend to obscure any residual thematic influences). Examples of the standard salutation and closing are so ubiquitous that no influence on the form of Miriam's letters should be claimed. However, Miriam's understanding of relative dating and its relation to the heading date is secure, in fact it now directs the form of her letters in this specific sense. She recently wrote a thank-you note for Christmas presents. No relative dating was used and the heading was undated. In immediate contrast is the letter copied below:

1/1/80

Dear Dara,
Did you get your Christmas
letter ? How are you I'm
fine. I might come up next week.
Do you think I could visit you ?
Last time I tried to visit you you
were not home and I would like
to see you. PS. How is your
family ? PPS. Turn over
the paper.

The reverse of the paper contains a large drawing of a "queen", duplicating a small decoration which Miriam had interposed between the salutation and the heading date. When I asked her at what point in composing the letter she wrote down the heading date and why she did so, Miriam responded, "When I was finished the letter, because I said I might come up NEXT week and she has to know when I wrote it."

DISCUSSION -

The issue of computer's suitability as a medium for writing instruction is confronted in an extreme form when the specific use is for introducing a child to writing. One advantage of a programmed machine is the capability for presenting the structure of

written material as conventional scripts. Through presenting a conventional form, into which a child can insert personalized content, the hope is to engage the child in a creation which could be valuable to her. Critics might argue that such an approach is entirely cosmetic, disguising the child's real ignorance with a covering of some other person's knowledge,mechanically reproduced. Such is a penetrating criticism, but its focus is more on the finished product than on the genetic intent of the tool. The intention is to engage the child in the creation of nearly conventional artifacts through which activity she might come to perceive what the organization is, typically, and what the significance of the elements is. (The clearest example is Miriam's finding out, in composing her letter to GG, that dated headings serve to disambiguate relative dating when the message is in the post for some uncertain time.) Further, if the child as author can create text which she is willing to dwell upon as reader, she may gradually perceive the structure of the text. For example, if a child perceives a short story as having a beginning ("Once upon a time,"), her part (the middle), and an end ("The end."), she may be expected to gradually vary and then dominate the beginning and end, which were not originally her own. Thus an initially unstructured form of expression would be fit, piecemeal, into those conventional forms which have been found effective for communication. The general view of learning to write is this: the learner gradually perceives how to analyze a form of text into parts and eventually may discover or invent meaningful interpretations and applications for those parts.

How extensible is this approach ? What else is there to write beside stories and letters ? With a utilitarian focus, other applications may be hard to imagine. Computer produced letters may be useful to a child as a grown-up disguise, i.e. they may permit her to send off requests for information, etc. that would have a grown-up

appearance and would more likely be honored than a letter obviously sent by a child. I find it hard to imagine any other "practical" advantage a child could gain in her everyday life from writing. If you look at text creation as another medium for enrichirg social relations, artistic expression, and as a path to self-knowledge, the possibilities are more promising. Miriam recently made me a Joke Book as a present. Does not the making of books and booklets offer considerable opportunity for personalized art-work and composition ? Title pages need decoration. Very large scale fonts could be done in intricate detail permitting complex colorings (by machine or by crayon). The mingling of graphics and text has enriched western art for thousands of years; similar work by children would not only be a joy to them in itself, but it could sensitize them to artistic traditions that now seem remote even to many adults.

What types of books might children make ? Surely they need not be restricted to jokes (though such would remain a popular genre). Some might be mathematical and artistic; I can easily imagine Robby creating a book of his computer designs with commentaries on which input values to his procedures generate the most attractive designs and why they do so. Children's story books often have elaborate pictures and simple texts. Could not a child also make stories and illustrate each action sentence with a drawing (mechanically made or otherwise) ? Cross-word puzzles would be another natural computer-based product for a child. The computer could neatly stack the little boxes and list the clues while the child did the hard intellectual work. Other puzzles, mazes and jokes would be ideally served by inverted text and mirror image fonts. For example, a child could declare in a standard font the riddle, "How do you get down from a horse ?" and print the answer, "You dont. You get down from a duck !" in some topsy-turvy font.

Computers offer a promising medium for enhancing functional literacy through improving writing. There is room for the development of general and application-specific language facilities which will render the computer's power more accessible to children without limiting their initiative. The development of such lexical or "word worlds" will not escape confronting major problems. Recall all the difficulty Miriam had with spelling. She could spell a few one, two and three letter words, but not much else. She was able to guess at some letters - usually the initial and terminal consonants - but she required spelling help on nearly every content word of all she wrote. I could help her because I recoded her oral/aural words as alphabetic letter strings. If a computer has no ears, must it not - like a dictionary - require you to spell a word so that it can tell you WHICH word you want to know how to spell ? Grappling with such problems may be one way the discipline of Artificial Intelligence can help to humanize the computer presence. Whatever form an effective spelling advisor might take, the constraints it generates should be considered in organizing the means of access to knowledge in any associated automated dictionary.

CONCLUSIONS -

We have seen in the material presented here an example of how one child was introduced to writing in a computer rich setting. This example highlights the suitability of computers for an introduction to writing which separates the structural elements of composition from its contents. Specific later developments of this one child's writing suggest her earlier experiences remained important as stereotypes of writing forms.

[1]. The formative ideas of the project are set out in a series of papers by Seymour Papert, available as Logo Memos 1, 2, 4, and 8.

[2]. My own work in this vein is best presented in another study of Miriam, ONE CHILD'S LEARNING, an M.I.T. Ph.D. Dissertation in Variform Intelligence. (R. W. Lawler, 1979). See Chapter II for a detailed study of Miriam's learning to add and Chapter III for a detailed study of the impact of computer experience on her thought. Other materials of article length are in preparation.